Jun 26th, 1:50 PM - 2:10 PM

Concurrent Sessions A: Emerging Engineering Solutions for Downstream Fish Passage at Big Dams - Survival Improvements at Fish Guidance Systems Designed to improve Safe Downstream Passage of Anadromous and Catadromous Fish

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S. Scott & Associates LLC

A Positive Barrier Guidance System Designed to Improve Safe Downstream Passage of Anadromous Fish

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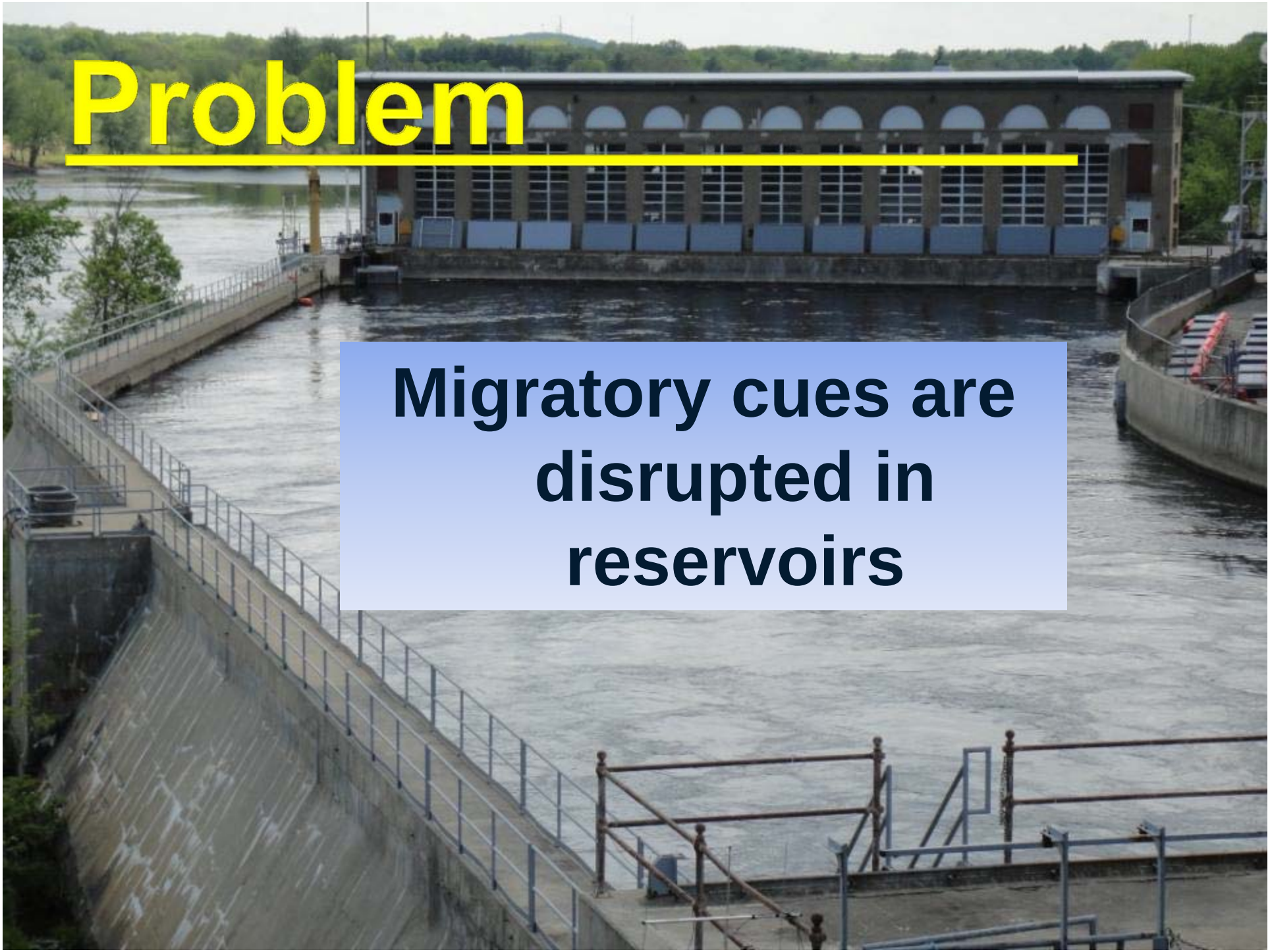
Juvenile Fish Passage Behavior

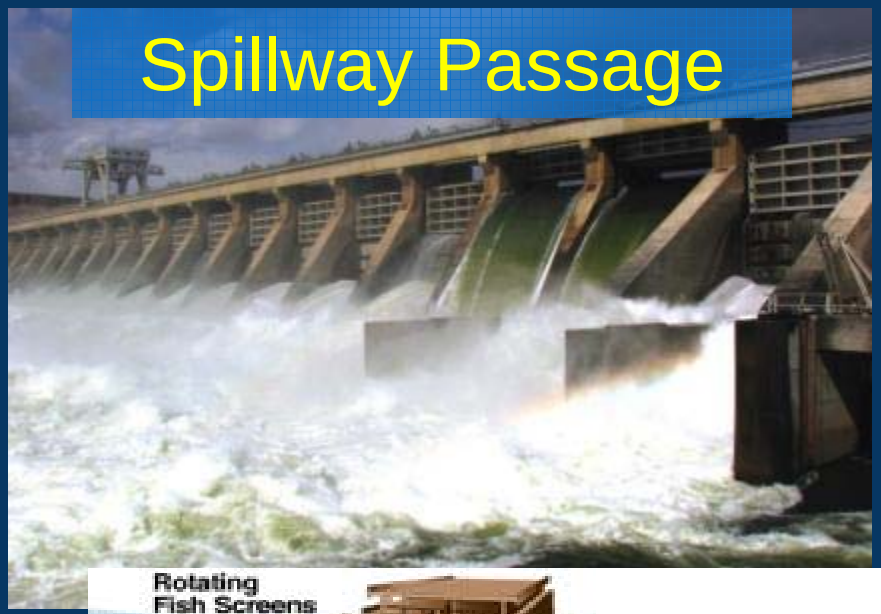
In general, juvenile anadromous salmonids and clupeids (river herring and shad):

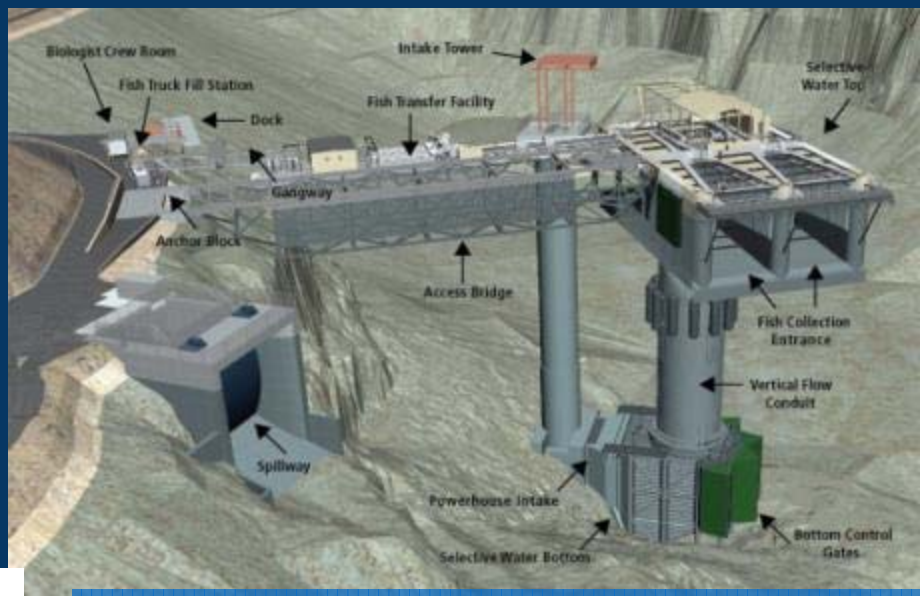
- **Follow bulk flow in the river thalweg**
- **Are surface oriented**
- **Cue on flow and turbulence**
- **May respond to changes in water quality**

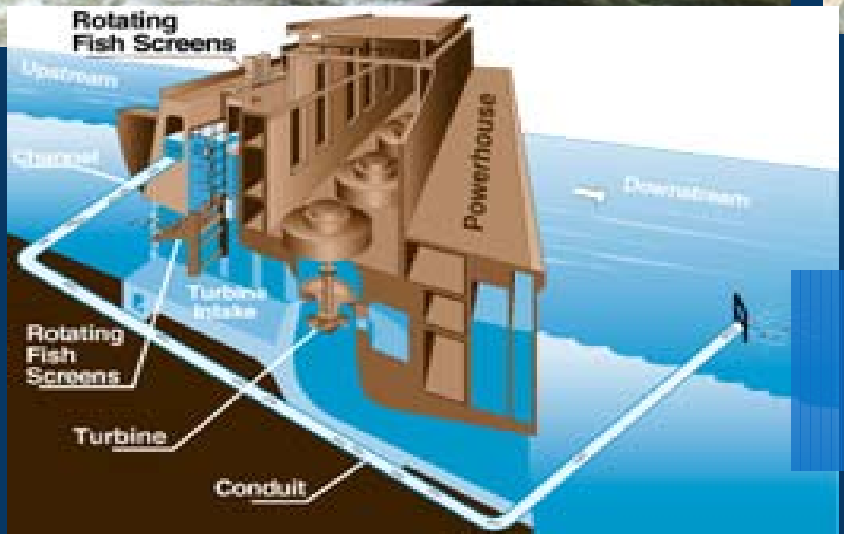

Problem
Migratory cues are disrupted in reservoirs

Juvenile Fish Bypass

Spillway Passage







Collection and Transport Systems

Screened Turbine Intake and Bypass

Non-Physical Guidance

Lights

Acoustic

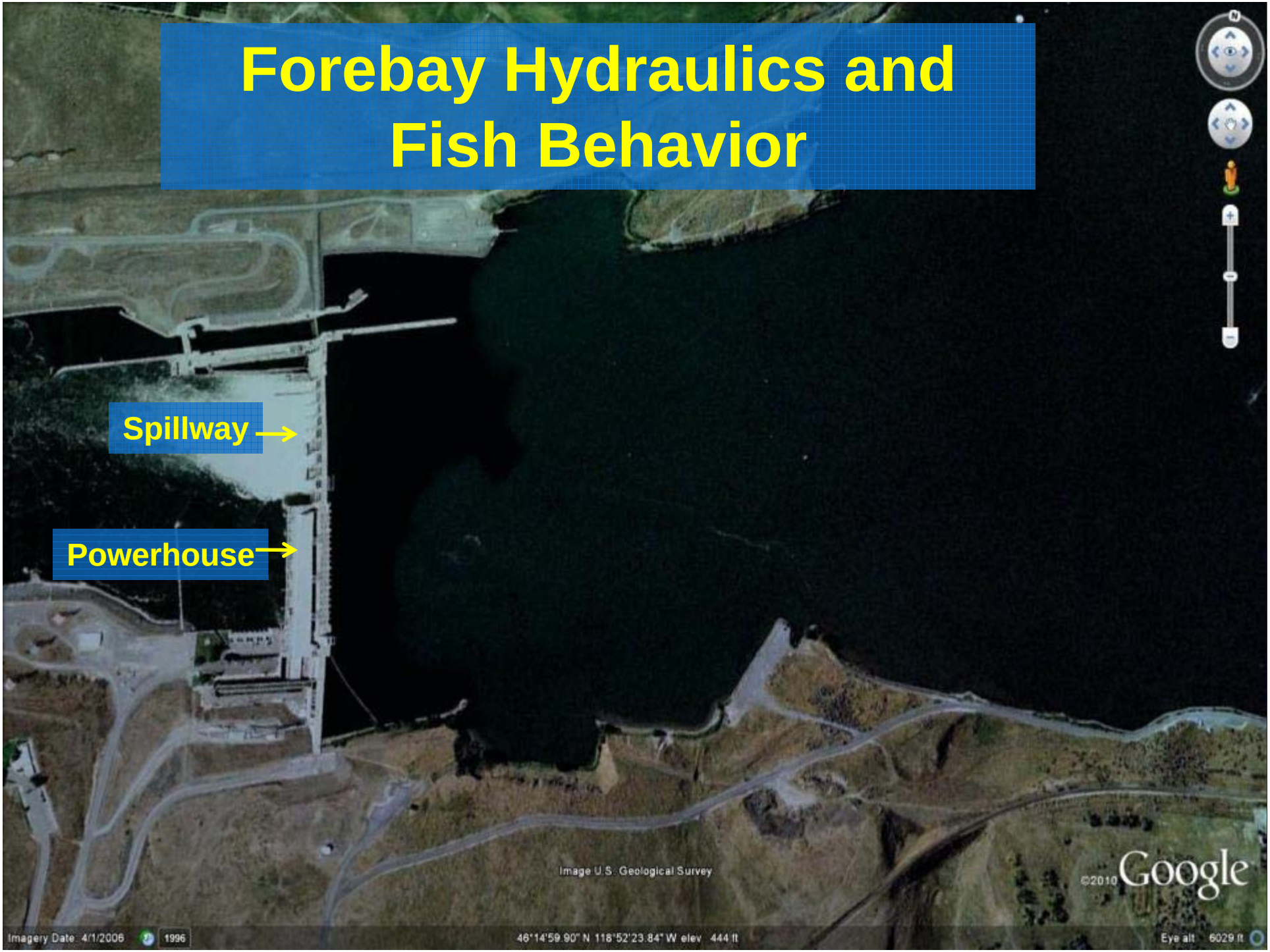
Bubble Curtains

Fish Guidance System

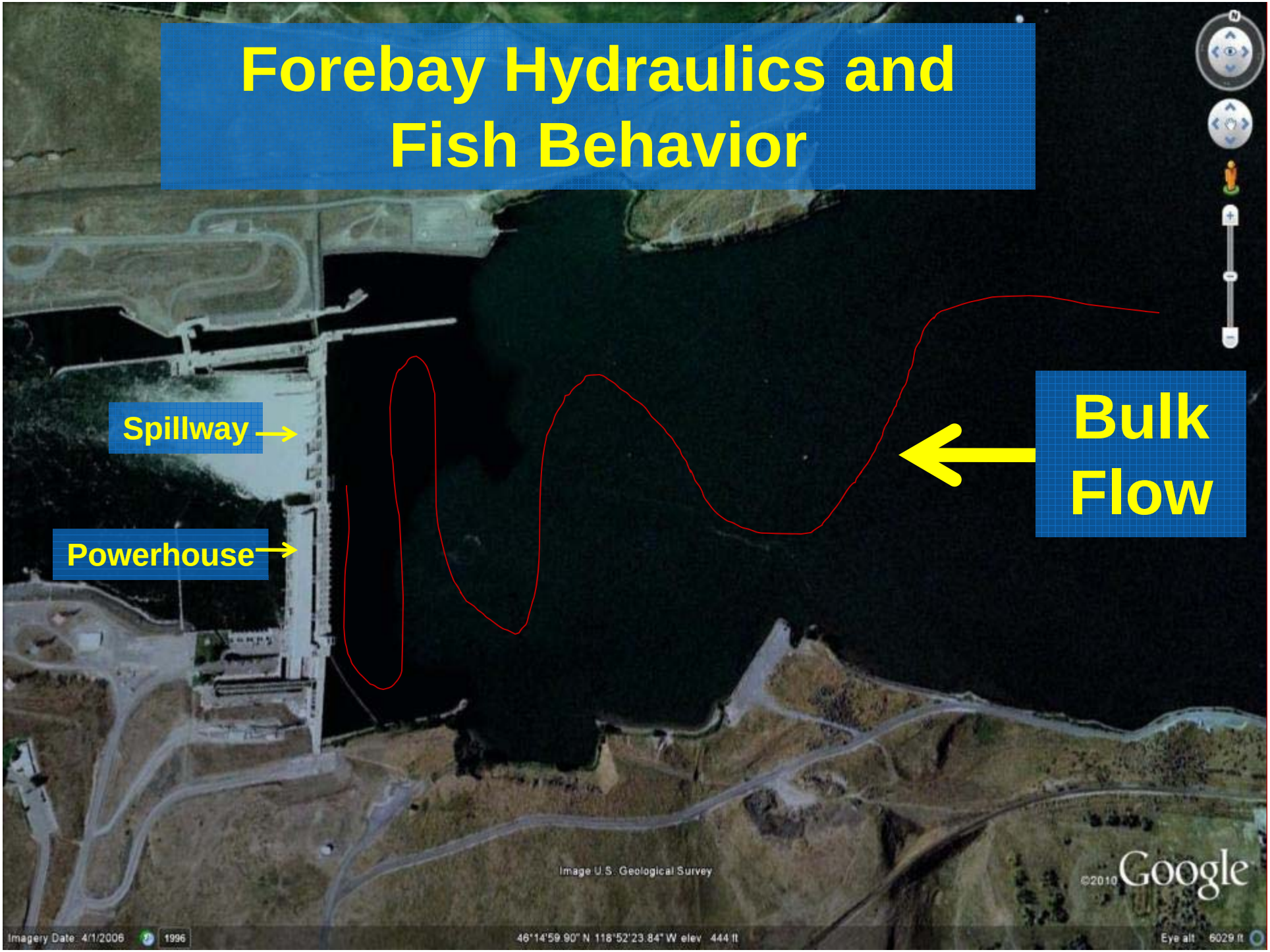
Fish Guidance System

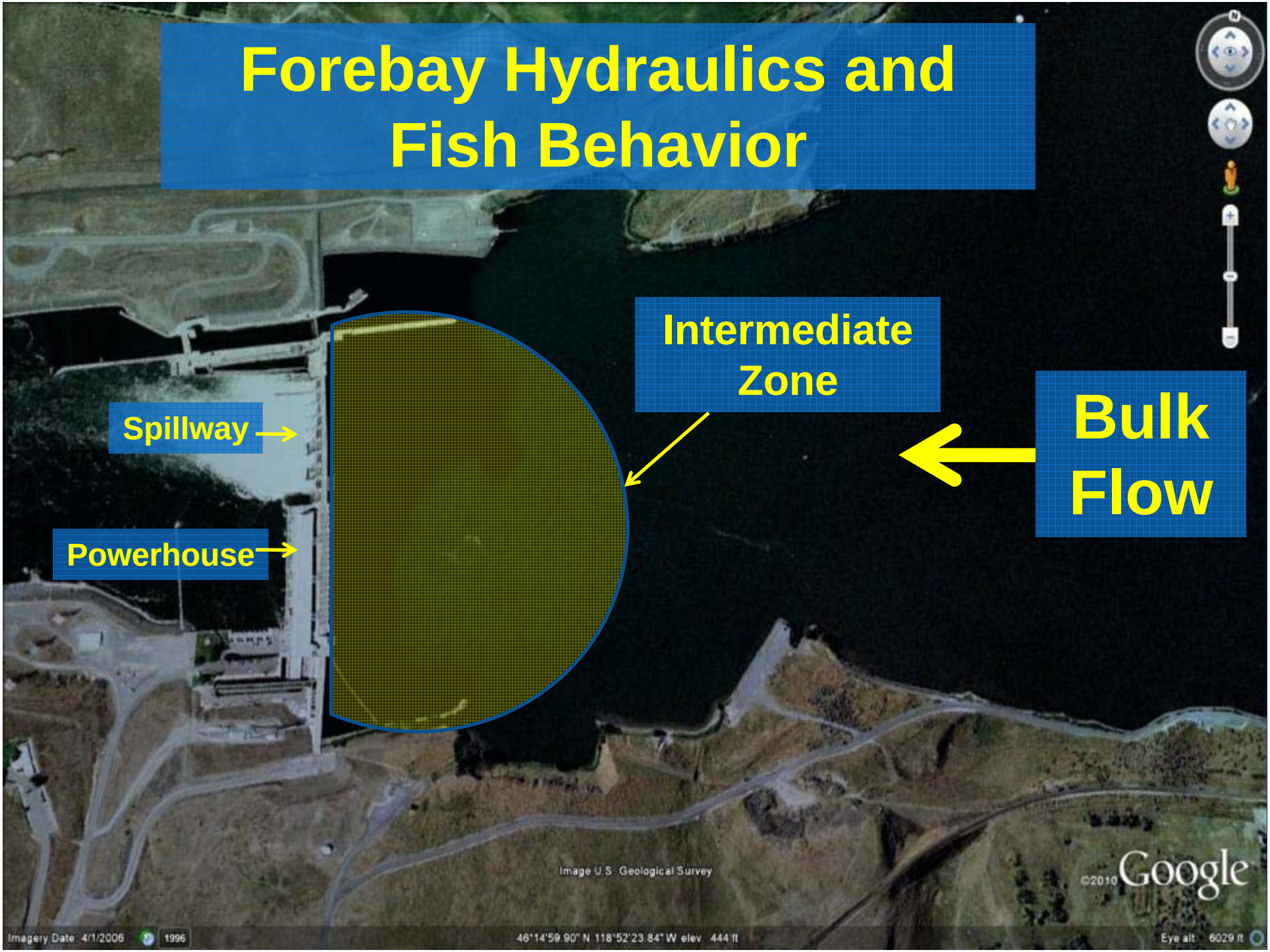
- Provides several cues to alter fish migration routes
  - Physical
  - Visual
  - Hydraulic

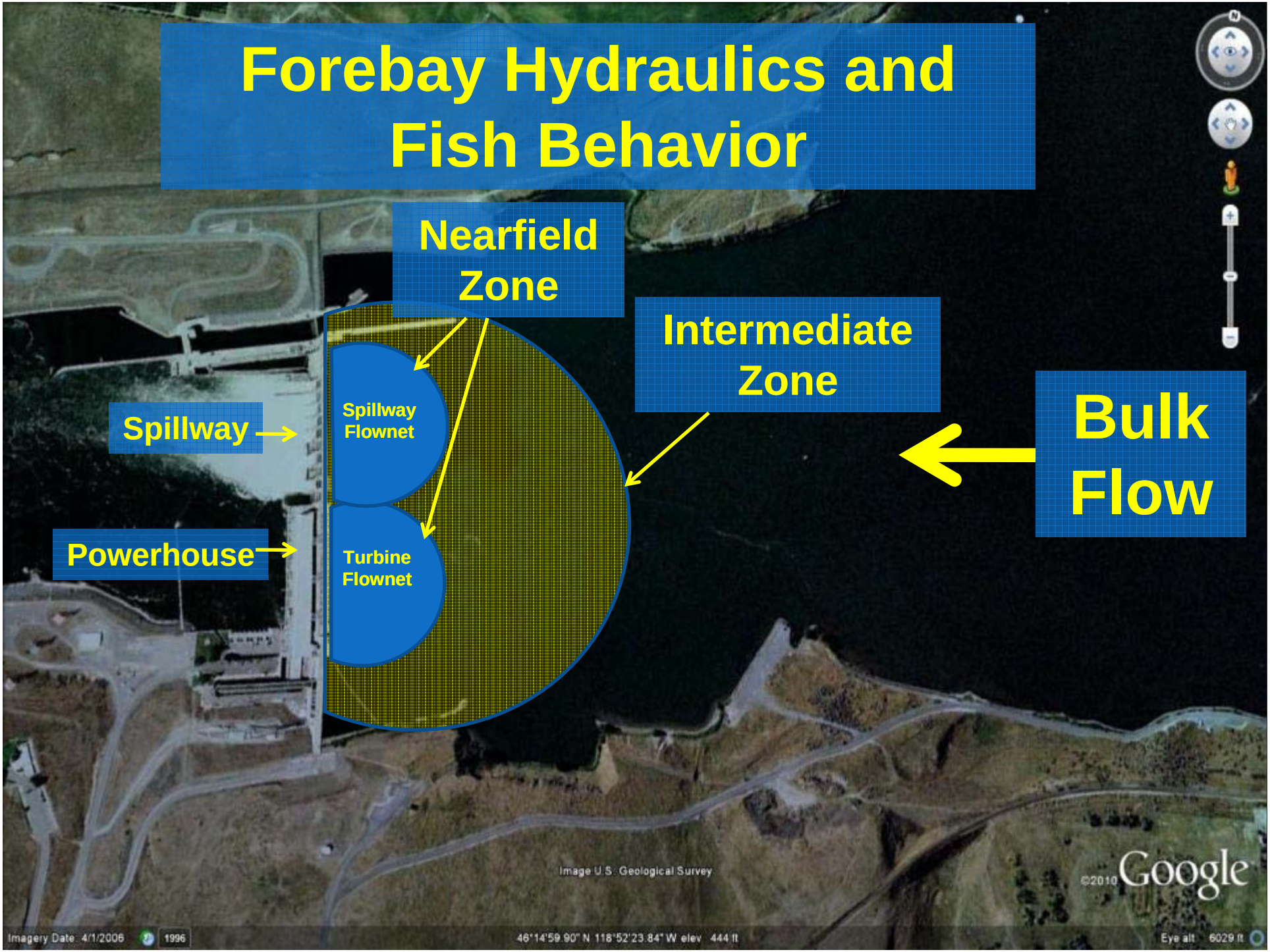
Forebay Hydraulics and Fish Behavior



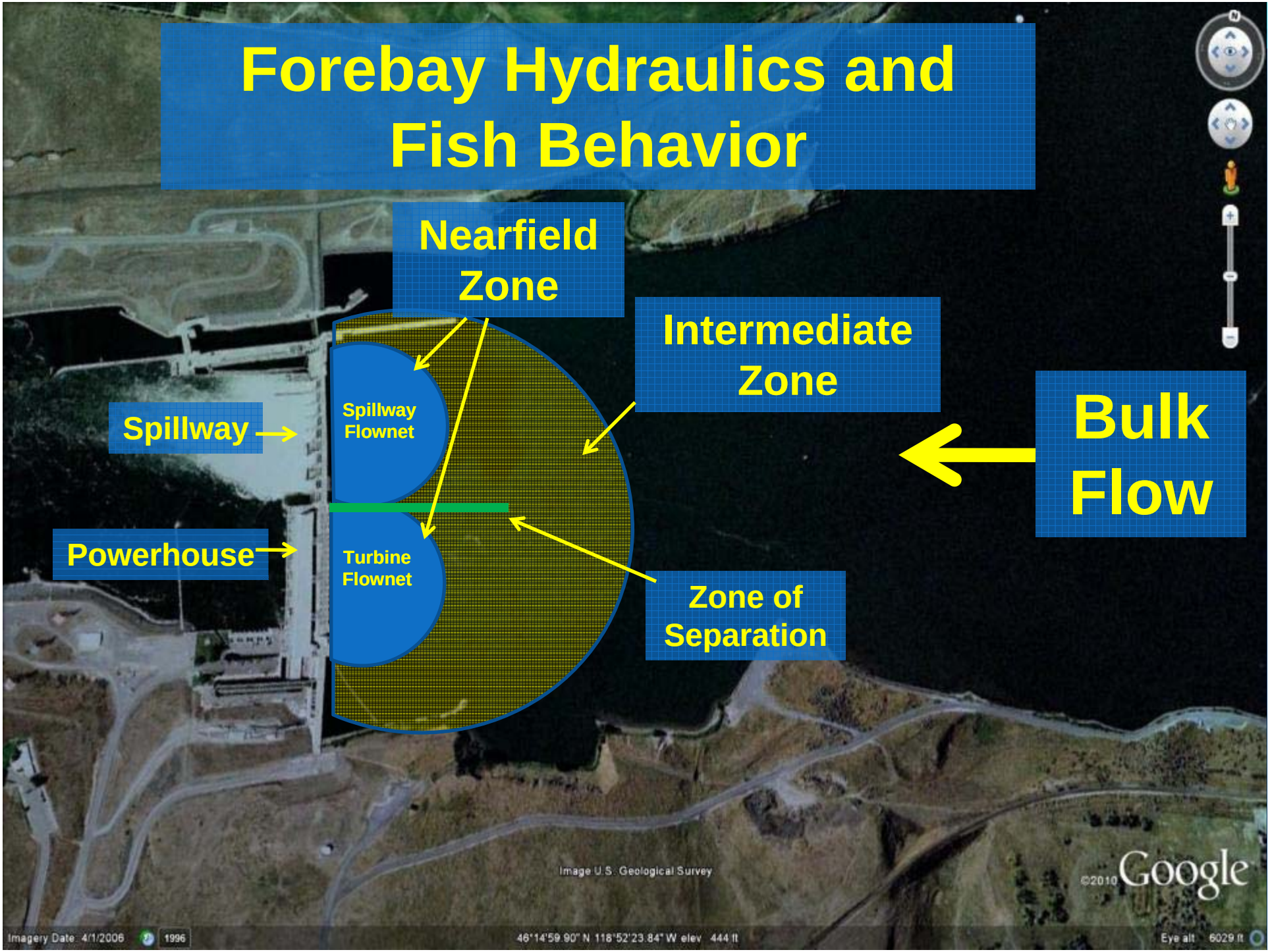
Forebay Hydraulics and Fish Behavior

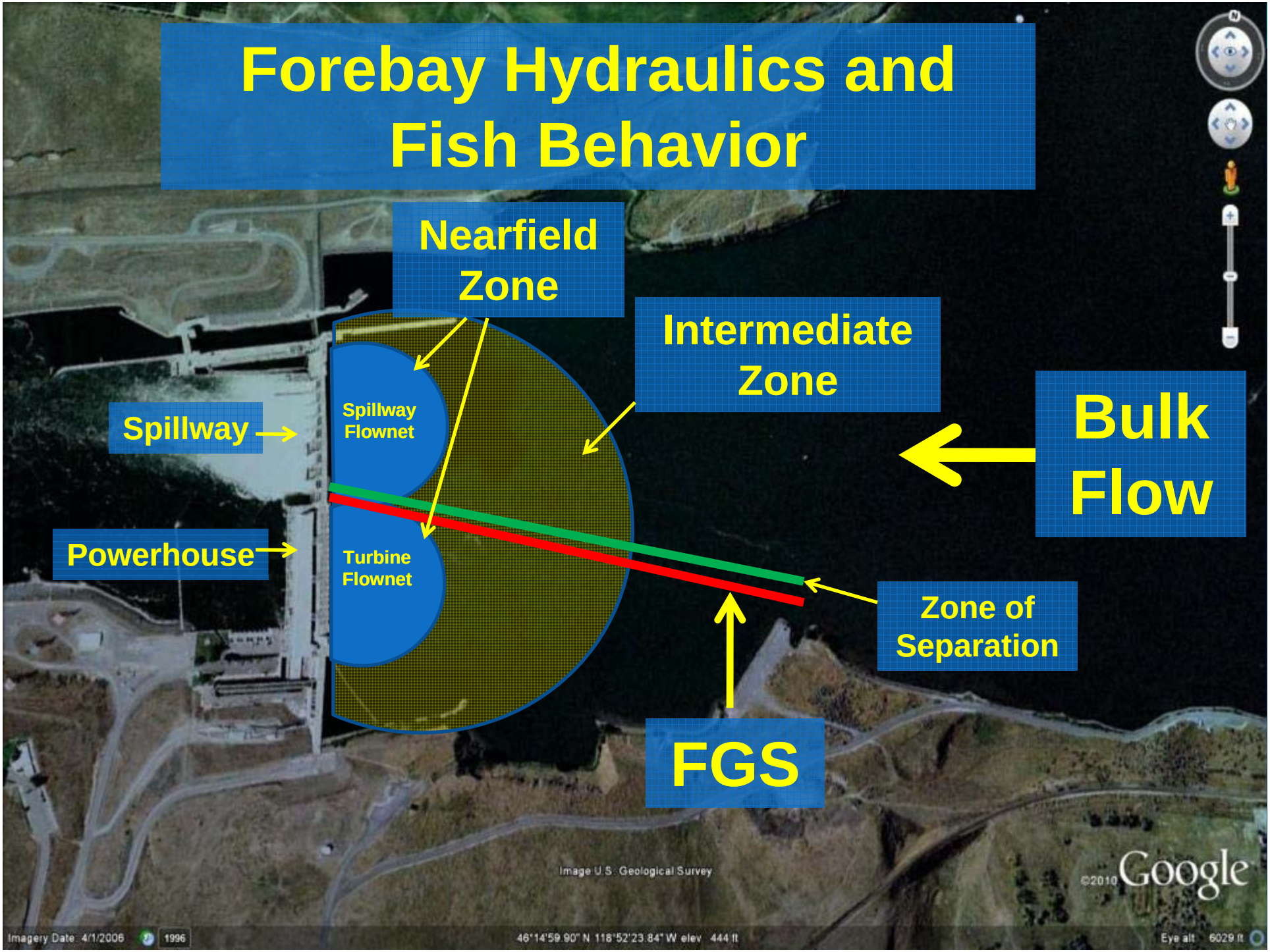


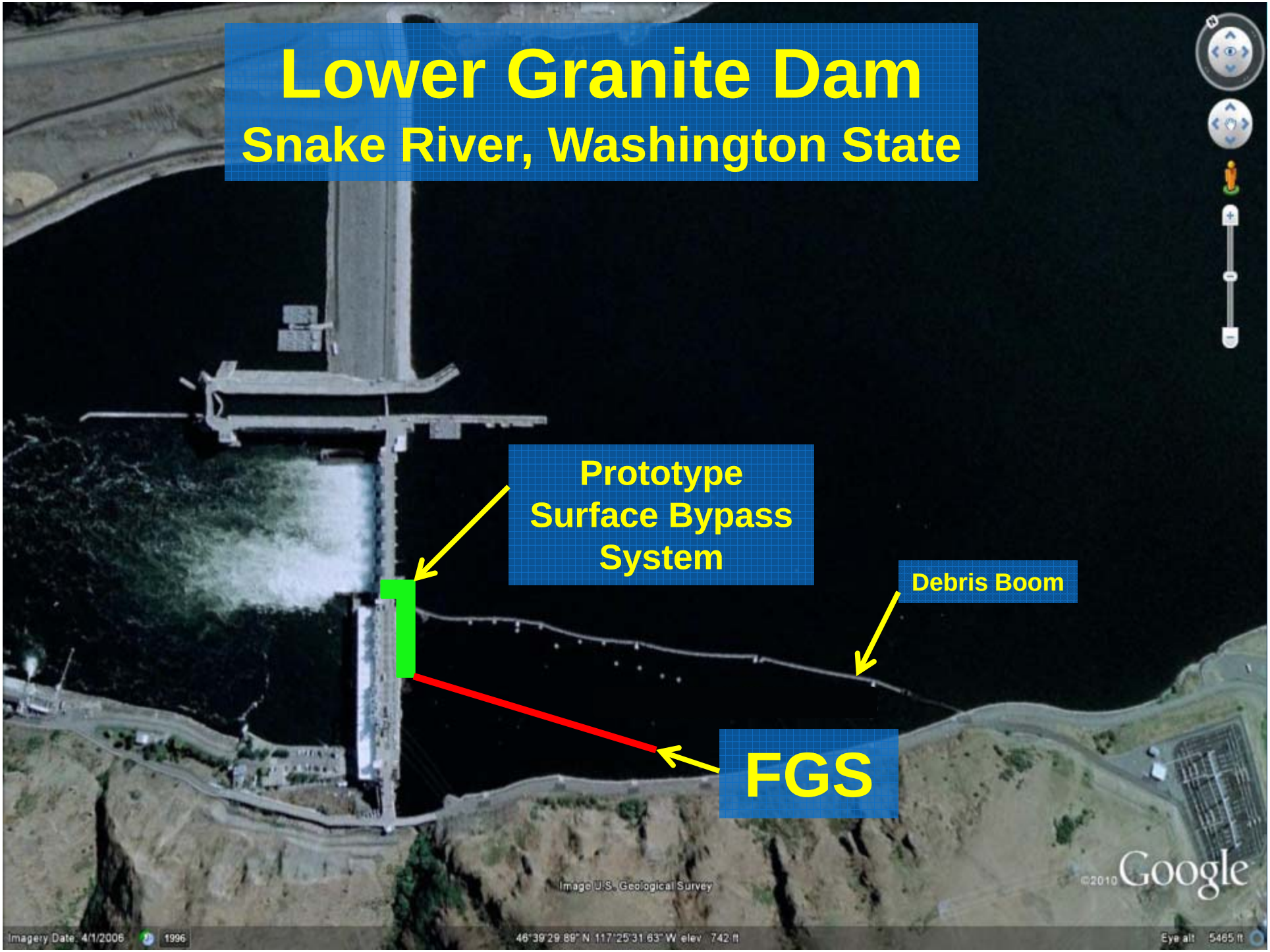

Forebay Hydraulics and Fish Behavior
Intermediate Zone
Bulk Flow
Spillway
Powerhouse
Image U.S. Geological Survey
©2010 Google
Imagery Date: 4/1/2006
1996
46°14'59.90" N 118°52'23.84" W elev 444 ft
Eye alt 6029 ft


Forebay Hydraulics and Fish Behavior
Nearfield Zone
Intermediate Zone
Bulk Flow
Spillway
Powerhouse
Spillway Flownet
Turbine Flownet
Image U.S. Geological Survey
©2010 Google
Imagery Date: 4/1/2006
1996
46°14'59.90" N 118°52'23.84" W elev 444 ft
Eye alt 6029 ft

Forebay Hydraulics and Fish Behavior

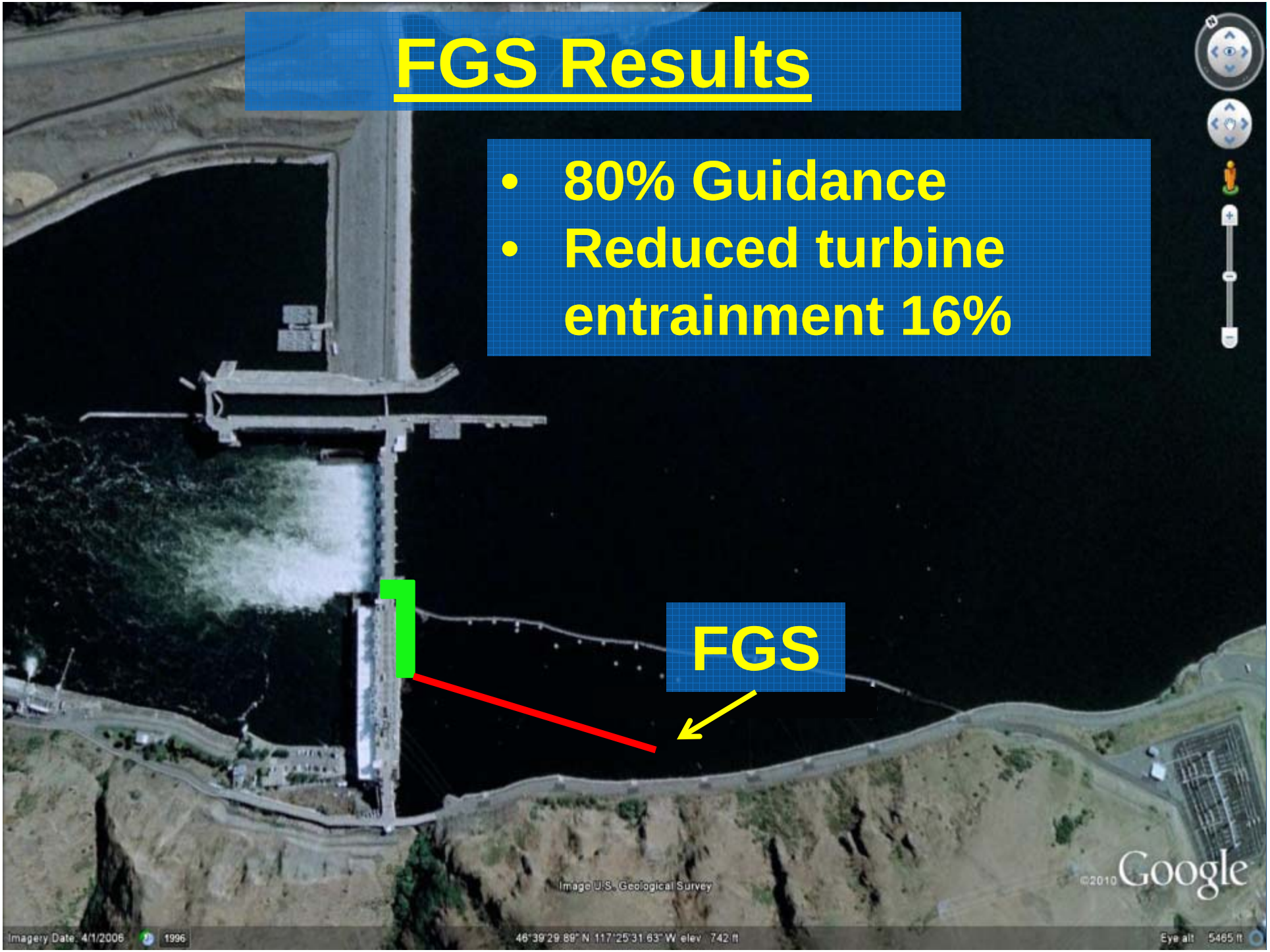



Forebay Hydraulics and Fish Behavior
Nearfield Zone
Intermediate Zone
Bulk Flow
Spillway
Spillway Flownet
Powerhouse
Turbine Flownet
Zone of Separation
FGS
Image U.S. Geological Survey
©2010 Google
Imagery Date: 4/1/2006
1996
46°14'59.90" N 118°52'23.84" W elev 444 ft
Eye alt 6029 ft

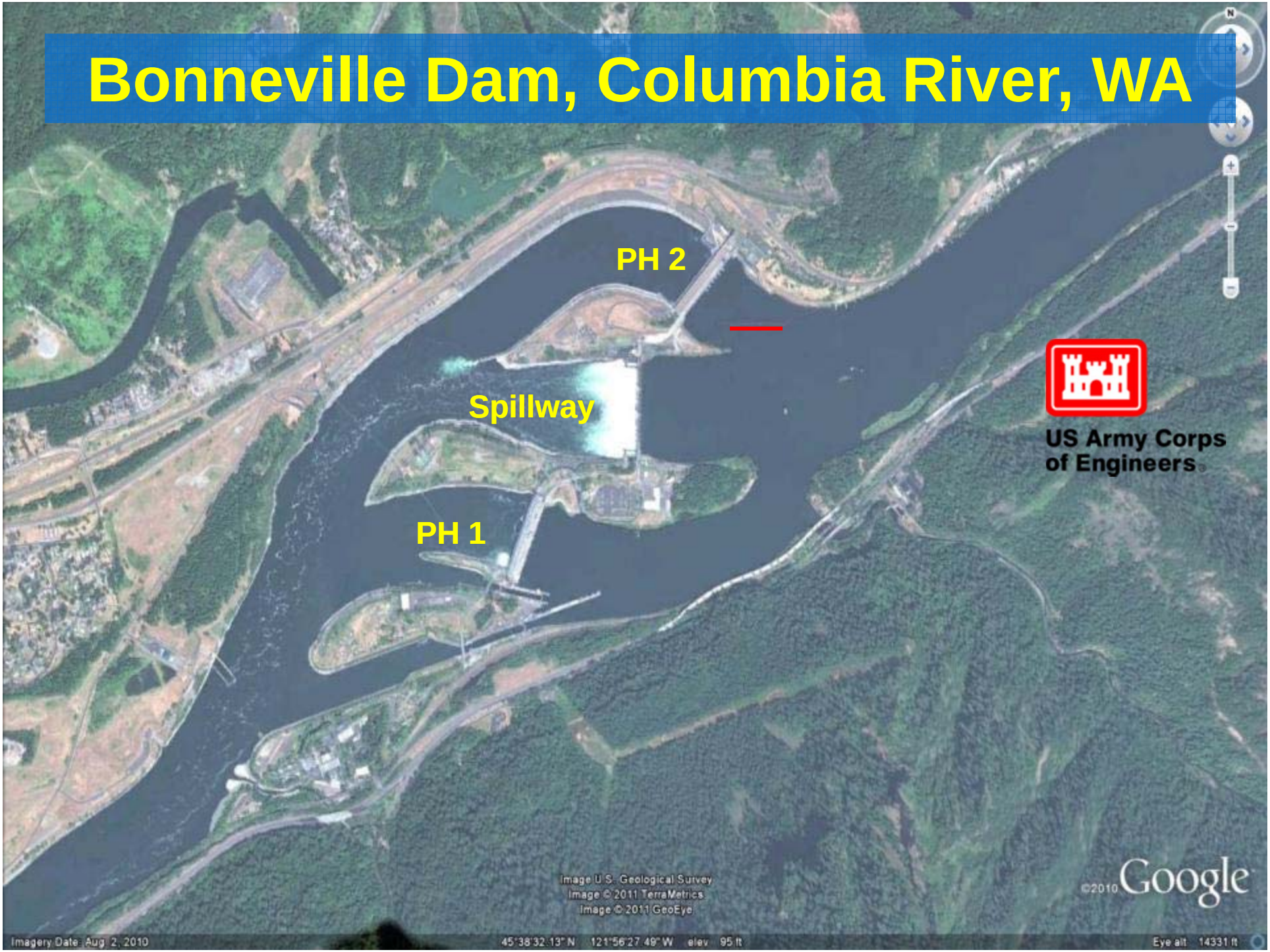

Lower Granite Dam
Snake River, Washington State
Prototype Surface Bypass System
Debris Boom
FGS
Image U.S. Geological Survey
©2010 Google
Imagery Date: 4/1/2006
1996
46°39'29.89" N 117°25'31.63" W elev 742 ft
Eye alt 5465 ft

FGS Results

- 80% Guidance
- Reduced turbine entrainment 16%



Bonneville Dam, Columbia River, WA



Bonneville Dam, Powerhouse 2
Fish Guidance System

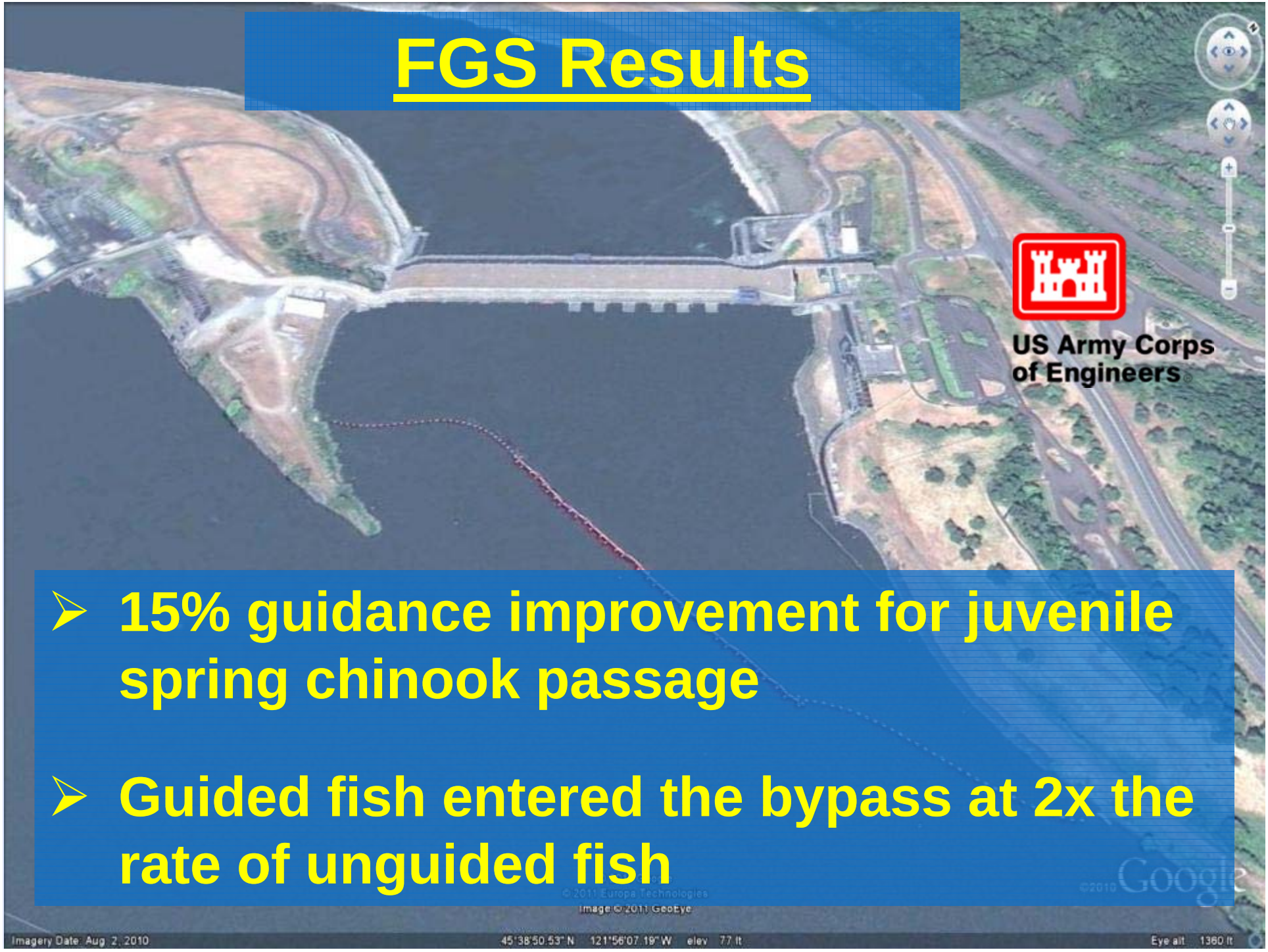
Powerhouse

US Army Corps of Engineers

Juvenile Bypass Channel

Fish Guidance System

FGS Results



- 15% guidance improvement for juvenile spring chinook passage
- Guided fish entered the bypass at 2x the rate of unguided fish

Cowlitz Falls Dam, Cowlitz River, WA

Surface Collector

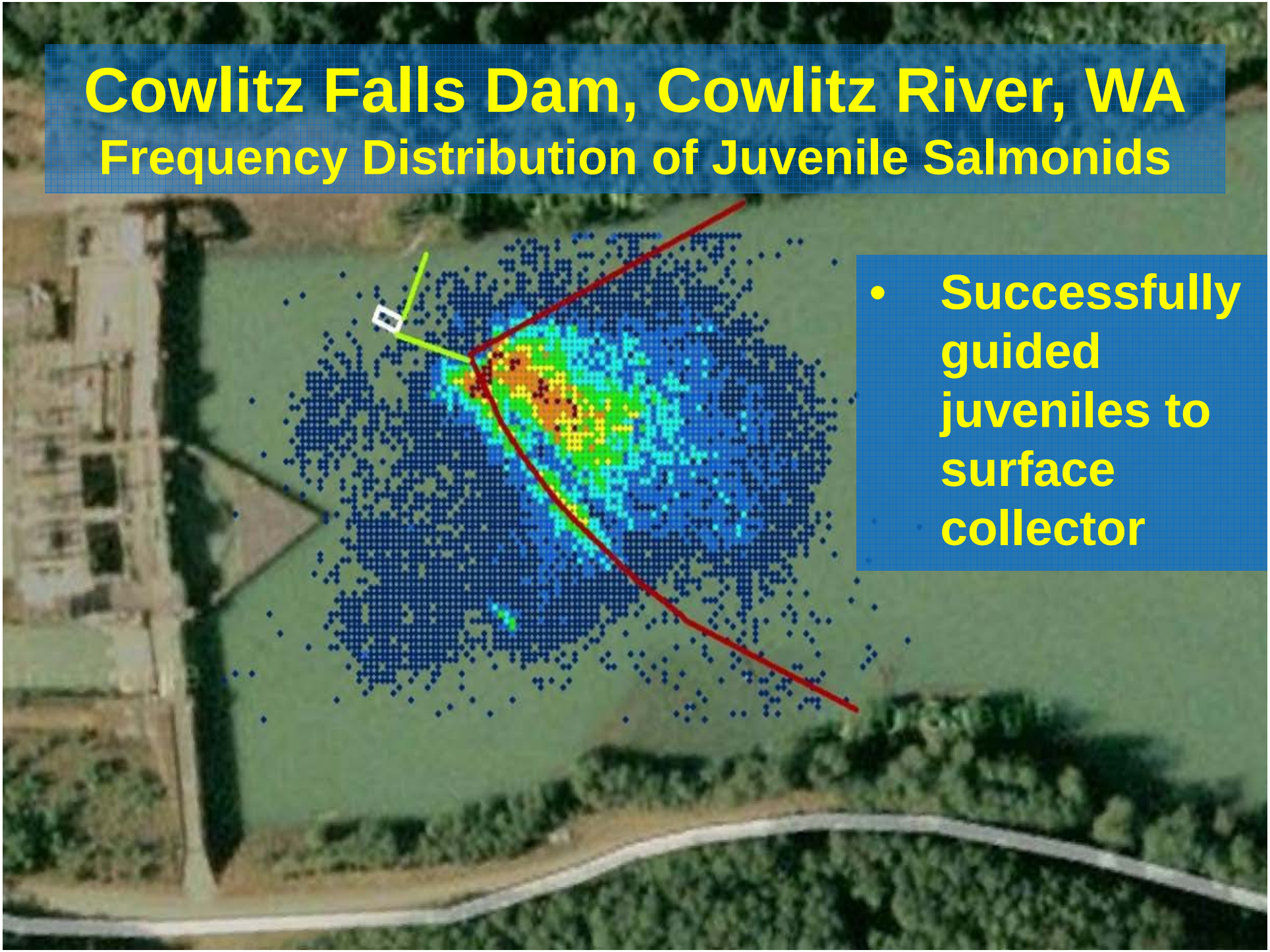
FGS

TACOMA POWER
TACOMA PUBLIC UTILITIES

Cowlitz Falls Dam, Cowlitz River, WA

Cowlitz Falls Dam, Cowlitz River, WA

Frequency Distribution of Juvenile Salmonids

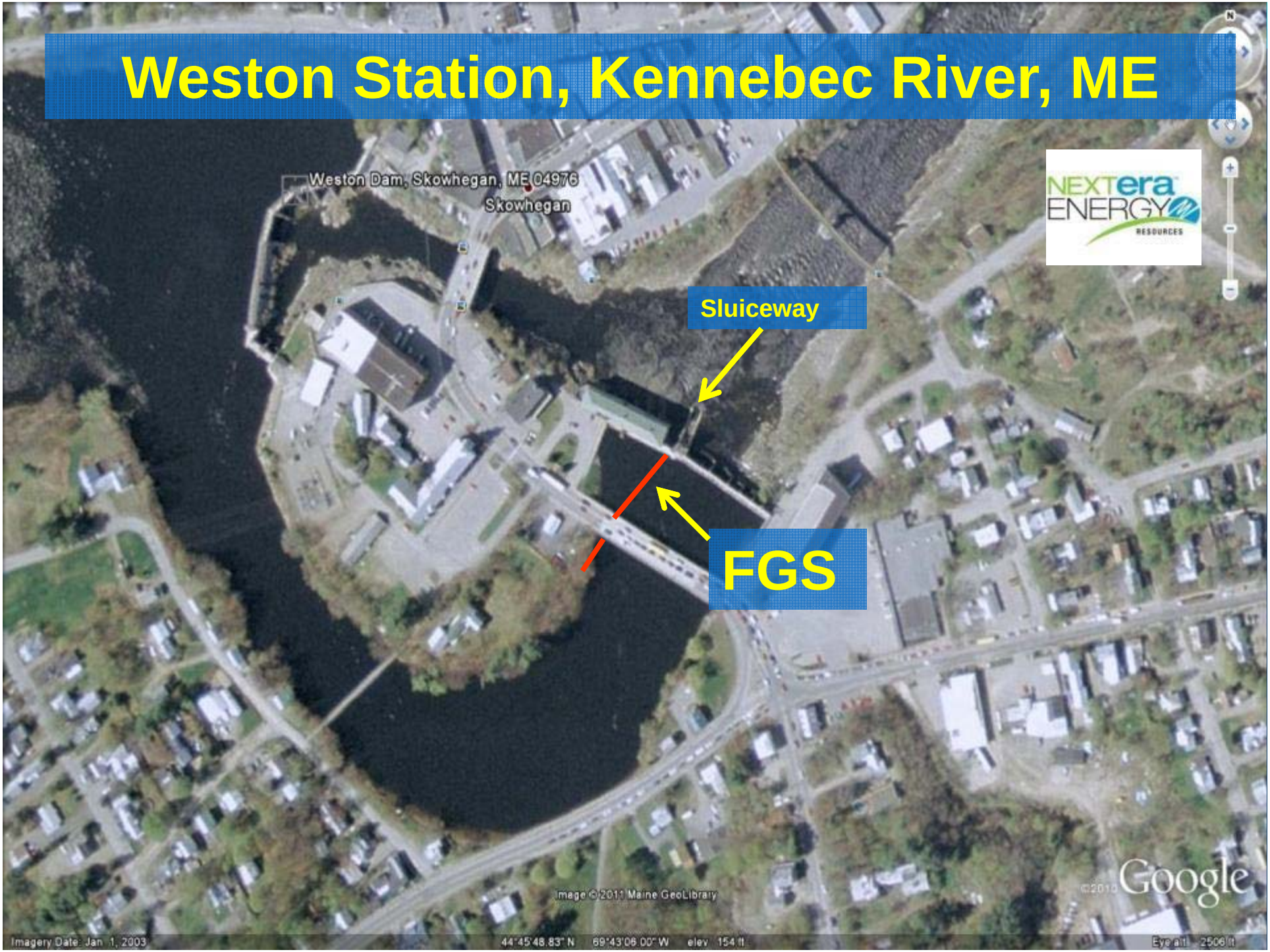


- Successfully guided juveniles to surface collector

Lockwood Station, Kennebec River, ME

Lockwood Station, Kennebec River, ME

Weston Station, Kennebec River, ME

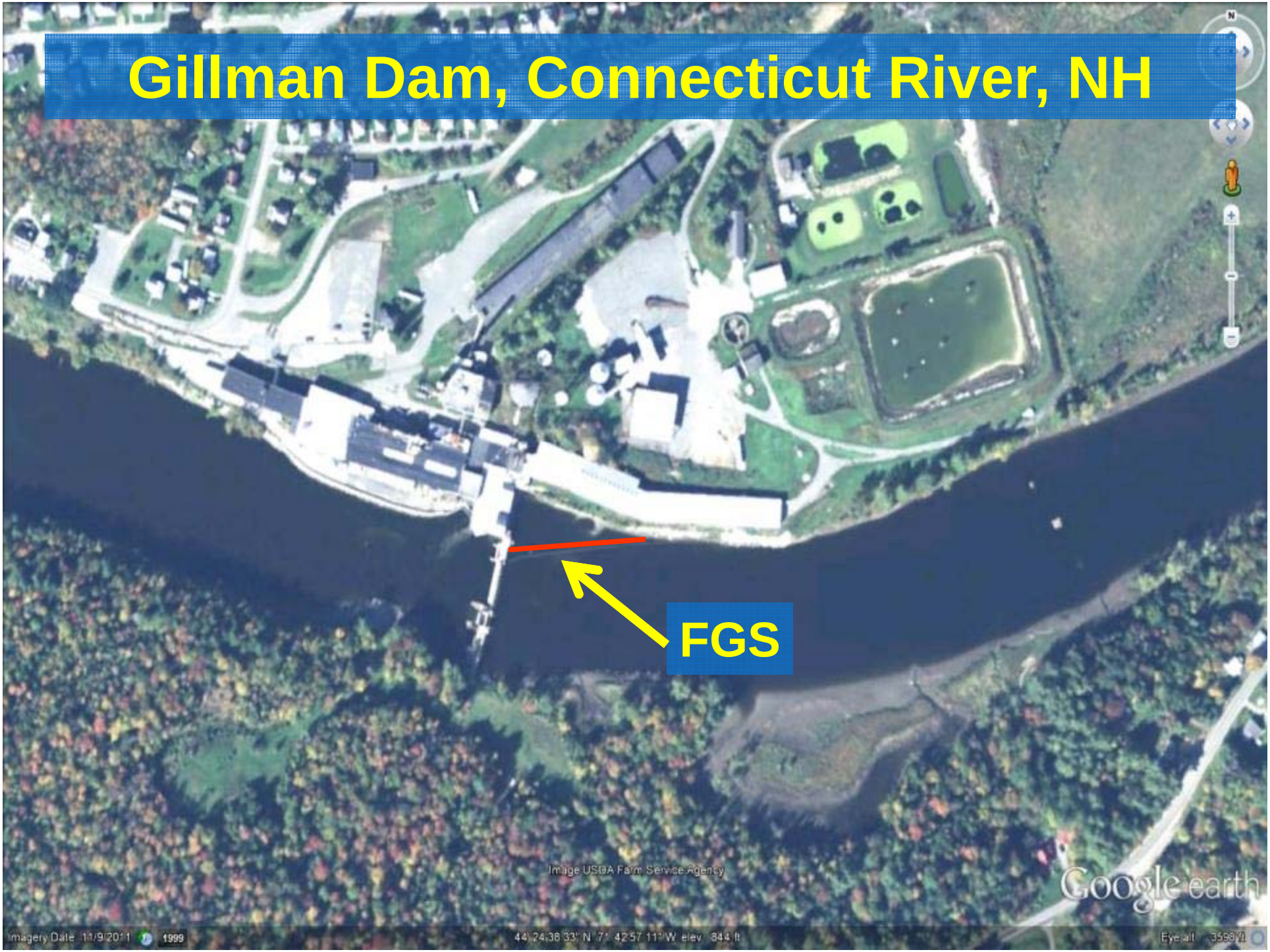


Weston Station, Kennebec River, ME

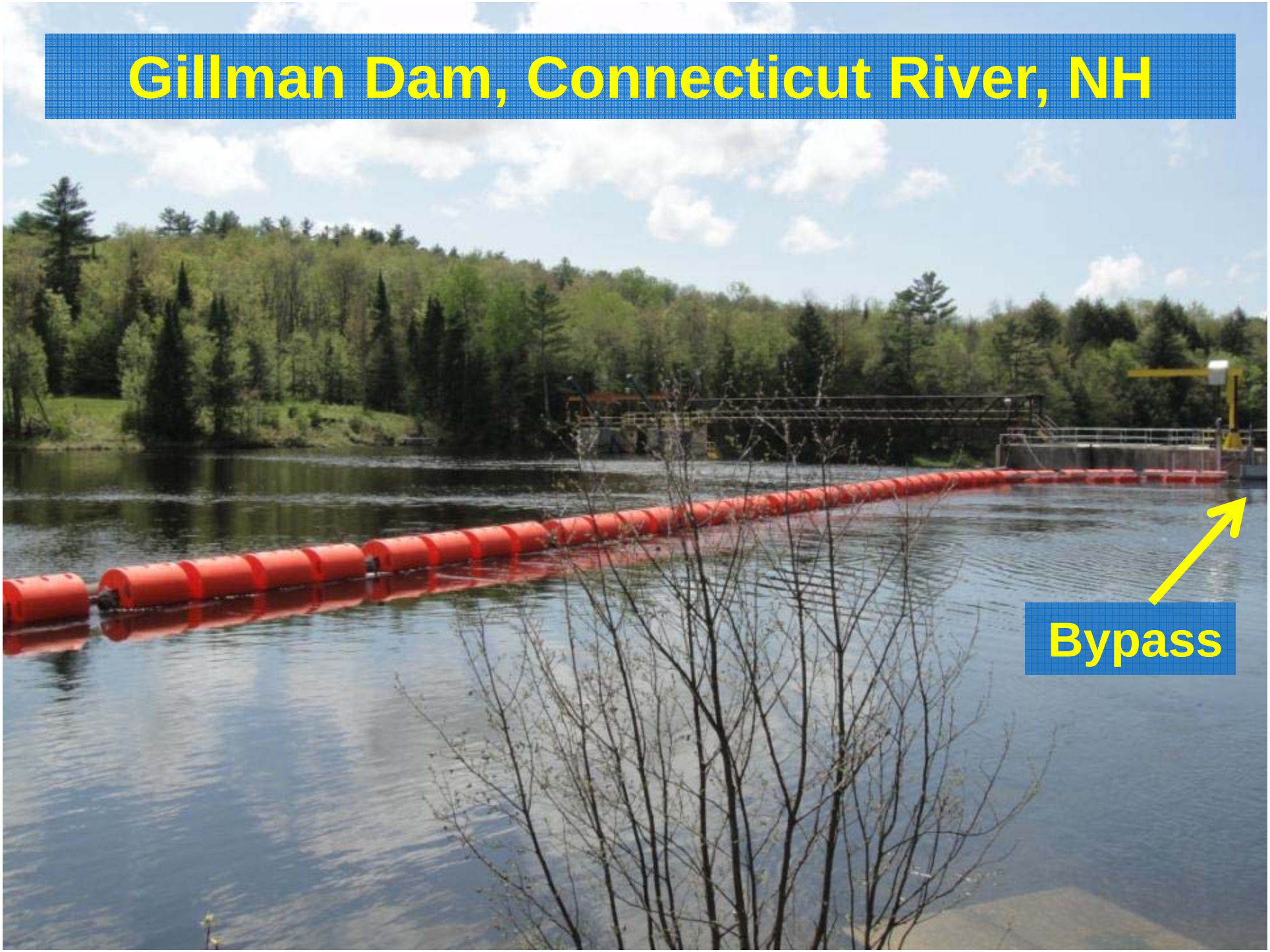
Kennebec Dam, Kennebec River, ME


Kennebec Dam, Kennebec River, ME
Bypass

Gillman Dam, Connecticut River, NH



Gillman Dam, Connecticut River, NH



Summary

- Permanent Physical Structure
- Significantly Improves Juvenile Fish Guidance and Survival
- Flexible Configuration to Allow Improvements
- Can Reduce Operations Costs

Recommendations

- Know Site Specific Conditions
- Provide Adequate Bypass
- Address Debris
- Work With Manufacturer
- Be Flexible – Modifications Will Further Improve FGS Performance

Thank You

Brookfield

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NEXTera ENERGY RESOURCES

WORTHINGTON
waterway barriers

US Army Corps of Engineers®

Fish Guidance System

QUESTIONS?